

Please add new dependent claims 19 and 20.

19. Process according to claim 17, further comprising storing the semiconductor wafer for at least 15 minutes in deionized water after contact with the aqueous treatment agent solution, before said cleaning of the semiconductor wafer.

*Deed*  
20. Process according to claim 18, further comprising flushing the treatment agent solution off the semiconductor wafer by using deionized water, after completing the oxidizing; and

storing the semiconductor wafer for at least 15 minutes in deionized water after contact with the aqueous treatment agent solution, before said cleaning of the semiconductor wafer.

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REMARKS

At the outset, the Applicants wish to thank Patent Examiner Robert Kunemund for the many courtesies extended to the undersigned attorney during the personal interview on April 19, 2001, at the U.S.P.T.O. The substance of this interview is set forth in the Examiner Interview Summary Record, and in this Amendment.

The amendments to the claims are as follows. Independent

claim 14 was revised to recite the additional step of cleaning the semiconductor wafer. New independent claim 17 recites the steps of claim 14 plus reciting the step of flushing the wafer by using deionized water. New dependent claim 19 depends from claim 17 and recites the further step of storing the wafer in deionized water.

Support for these amendments is found on page 6 in lines 8 to 16 of the present Specification.

New independent claim 18 recites the steps of claim 14 plus claims 9 and 12. New dependent claim 20 depends from claim 18 and recites the further steps of flushing the wafer with deionized water and storing the wafer in deionized water.

The Applicants comment upon the prior art rejection of the claims as follows.

The present invention is directed to a process for treating a semiconductor wafer, comprising polishing the semiconductor wafer; immediately after polishing the semiconductor wafer removing the semiconductor wafer from a polishing plate; bringing the semiconductor wafer into contact with an aqueous treatment agent solution for oxidizing a polished surface of the semiconductor wafer by action of the aqueous treatment agent

solution; the wafer being brought into contact with the aqueous treatment agent solution in a manner which is selected from the group consisting of (a) spraying the semiconductor wafer with the aqueous treatment agent solution, (b) dipping the semiconductor wafer into the aqueous treatment agent solution and (c) applying the aqueous treatment agent solution to the polished surface of the semiconductor wafer by means of a cloth which has been moistened with the aqueous treatment agent solution; and cleaning the semiconductor wafer.

Claims 6, 7 and 9 to 16 were rejected under 35 U.S.C. 103 as being unpatentable over *Fabry* U.S. Patent No. 5,219,613 in view of *Haysashida* U.S. Patent No. 5,580,846.

There are significant differences between the references cited and the claims of the present patent application. An important innovation of the invention concerns the fact that it is mandatory that the wafers are subjected to an oxidizing treatment immediately after having removed the wafers from the polishing plate.

However, *Fabry* US Patent No. 5,219,613 does not disclose or teach such a combination of process steps. In column 2, lines 27-43 it is only stated that polished wafers are subjected to an oxidative treatment, e.g. with an alkaline solution like

ammoniacal hydrogen peroxide solution. However, the reference absolutely does not anticipate performing the oxidative treatment immediately after having removed the wafers from the polishing plate. Instead, it is taught that the wafers are first cleaned, i.e. freed of polishing residues and then subjected to the oxidative treatment (Please see column 5, lines 59-63).

According to a statement of one of the inventors of the present invention, he found that about 80% of the polished wafers had etch marks which resulted from the presence of polishing agent residues remaining on the wafers. This occurred when the wafers had been cleaned after polishing instead of subjecting them to a prior oxidative treatment as claimed. Therefore, the *Fabry US Patent No. 5,219,613* clearly teaches away from the present invention.

In addition to the above, the *Fabry U.S. Patent No. 5,219,613* in column 1 in lines 10 to 13 discloses a process for producing storage-stable surfaces of polished silicon wafers by oxidative treatment and subsequent exposure to organosilicon compounds.

*Fabry* in column 2 in lines 27 to 36 discloses a process for producing storage-stable surfaces of polished silicon wafers

comprising oxidative treatment of the silicon wafers; subsequently exposing the silicon wafers to an active organosilicon compound; and selecting as said active organosilicon compound one which contains at least one radical in the compound which is hydrolyzably bound to silicon and at least one radical in the compound having hydrophilic properties.

Fabry in column 2 in lines 37 to 56 discloses a prior oxidative treatment of the silicon wafer, as a result of which its surface is coated with a thin oxide layer, can be carried out in a known manner. For example, this can be in an aqueous alkaline solution, in particular, ammoniacal hydrogen peroxide solution (for example, analogously to the procedure in the "RCA cleaning"). Also this can be in aqueous acidic solution, in particular hydrogen peroxide solution containing hydrochloric acid, or in an ozone-containing aqueous solution. Solutions which contain, for example, hypochlorites such as, for instance, sodium hypochlorite, as oxidizing agent are also suitable.

The wafers can also be oxidized anodically in alkaline solution. In the last mentioned cases, however, a possible contamination of the wafer surface with interfering cations must be borne in mind. In addition, there is also the possibility of oxidation via the gas phase, which may be carried out, for example, by exposure to ozone or as a so-called thermal oxidation

in a dry or moist oxygen-containing atmosphere.

Fabry in column 2 in lines 57 to 68 discloses subsequent to such an oxidative treatment, which possibly comprises even a combination of a plurality of steps, the wafers, which are, as a rule, in a single-sidedly or double-sidedly polished form and consequently have at least one polished wafer surface, are advantageously also washed and dried in order to prevent interfering side reactions with the organosilicon compounds to which they are subsequently exposed. Expediently, the wafers are subjected to this exposure as promptly as possible subsequent to the oxidative treatment, although, according to experience, waiting times of up to about 12 hours have been found to be still tolerable.

Fabry in column 4 in lines 29 to 39 discloses examples of organosilicon compounds which are, according to experience, particularly well-suited and contain at least one radical hydrolyzably bound to silicon and a hydrophilic radical and which contain, at the same time, a comparatively low proportion of carbon are tetramethoxysilane, methoxychlorodimethylsilane, mixtures of these two compounds, preferably in the ratio of 1:3 to 1:9, mixtures of tetramethoxysilane and dimethoxymethylchlorosilane, advantageously in the same mixing range, and also di(2-chloroethoxy)dimethylsilane or

dimethyldimethoxysilane. The use of an organosilicon compound teaches away from flushing with deionized water and storing in deionized water, as claimed.

In addition, there are several other differences between the present invention and *Fabry et al.* (U.S. Patent No. 5,219,613). According to the invention the semiconductor wafer is subjected to an oxidizing treatment immediately after polishing. *Fabry et al.* teach freeing the wafer from polishing residues before subjecting them to an oxidative cleaning (See column 5, lines 59-67). Moreover, as claimed in new claims 17 to 20, the wafer is flushed with deionized water and the wafer is stored for at least 15 minutes after the oxidizing treatment in deionized water before being subjected to a cleaning step. *Fabry et al.* fail to teach flushing and storage in deionized water before cleaning the wafer. In column 6, lines 1-10 of *Fabry*, *Fabry* teaches storage in a polyethylene packaging unit, not deionized water.

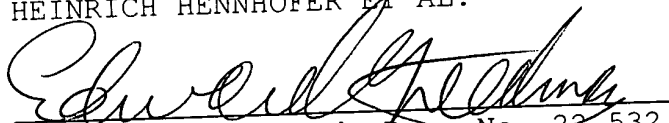
The deficiencies in the teachings of the primary reference *Fabry* are not overcome by the disclosure of the secondary reference to *Hayashida*. *Hayashida* in column 7 in lines 49 to 50 teaches that the silicon wafers can be immersed into the treating solution. However, there is no teaching as to the timing of this immersion by *Hayashida*. Also there is no teaching of using deionized water for flushing and storing of the wafers.

As to Hayashida US Patent No. 5,580,846, it is submitted that this reference is not pertinent at all. This patent refers to surface treatment agents and to a process for treating semiconductor wafers. However, there is no teaching at all that the treatment has to be performed at a specific time, i.e. immediately after having polished semiconductor wafers. Moreover, the reference teaches having a complexing agent being present in the oxidizing treatment agent or rinsing the wafers with water containing a complexing agent after the treatment with the oxidizing treatment agent (please see column 3, lines 43-58). This teaches away from flushing and storing the wafer in deionized water.

In summary, claim 14 has been amended. New claims 17 to 20 have been added. In view of these amendments, it is believed that the invention, and all the claims, are patentable over all the prior art applied by the Patent Examiner under 35 U.S.C. 103. Withdrawal of this ground of rejection is respectfully requested. A prompt notification of allowability is respectfully requested.

Respectfully submitted,  
HEINRICH HENNHÖFER ET AL.

By:

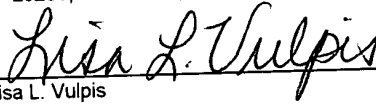
  
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- Encl.: 1. Marked-Up Version of Amended Claim  
2. Copy of Petition for Three Month Extension of Time for  
Large Entity

I hereby certify that this correspondence is being deposited with the U.S. Postal Service as first class mail in an envelope addressed to:  
Assistant Commissioner of Patents, Washington, D.C. 20231, on June 18, 2001.

  
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Lisa L. Vulpis

MARKED-UP VERSION  
OF AMENDED CLAIM

14. (Amended) Process for treating a semiconductor wafer,  
comprising

polishing the semiconductor wafer;

immediately after polishing the semiconductor wafer removing  
the semiconductor wafer from a polishing plate;

bringing the semiconductor wafer into contact with an  
aqueous treatment agent solution for oxidizing a polished surface  
of the semiconductor wafer by action of the aqueous treatment  
agent solution, [and]

the wafer being brought into contact with the aqueous  
treatment agent solution in a manner which is selected from the  
group consisting of (a) spraying the semiconductor wafer with the  
aqueous treatment agent solution, (b) dipping the semiconductor  
wafer into the aqueous treatment agent solution and (c) applying  
the aqueous treatment agent solution to the polished surface of  
the semiconductor wafer by means of a cloth which has been  
moistened with the aqueous treatment agent solution[.]; and

cleaning the semiconductor wafer.